*Journal of the Lepidopterists' Society*
58(4), 2004, 223-227

# NOTES ON THE STATUS, NATURAL HISTORY AND FIRE-RELATED ECOLOGY OF *STRYMON ACIS BARTRAMI* (LYCAENIDAE)

**Additional key words**: Croton, Florida, West Indies, prescribed fire.

The Bartram's hairstreak, *Strymon acis bartrami* (Comstock & Huntington) (Lycaenidae) (Fig. 1) is endemic to southern Florida and the lower Florida Keys (Baggett 1982, Schwartz 1987, Minno & Emmel 1993, Smith et al. 1994). Although still occurring locally in parts of Monroe and Miami-Dade Counties, populations of this subspecies have been extirpated from the majority of its historic range, which may have extended northward to Palm Beach County on eastern peninsular Florida (Baggett 1982, Minno & Emmel 1993, Minno & Emmel 1995Smith et al. 1994) (Fig. 2). A number of studies have been undertaken to survey the remaining populations of *S. a. bartrami* and to attempt to identify factors contributing to their decline in recent decades (Schwartz 1987, Hennessey & Habeck 1991, Hennessey et al. 1992, Schwarz et al.1996, Emmel et al. 1996, Salvato 1999, 2001, in press). The purpose of this paper is to provide an updated discussion on the role of fire on the population ecology of *S. a. bartrami* within the pine rocklands of south Florida and the keys. We also present natural history observations of *S. a. bartrami* natural history elicited during our field studies.

***Strymon a. bartrami* and fires**. Pineland croton, *Croton linearis* Jacq. (Euphorbiaceae), the sole host plant of *S. a. bartrami*, is restricted to pine rockland habitat (Schwarz et al. 1996, Salvato 1999). Modern development has removed and/or fragmented the pine rocklands from the majority of their former range on peninsular Florida and the lower Florida Keys (Anonymous 1999, Salvato 1999). Historically, pine rockland habitat covered 65,450 ha within Miami-Dade County (Loope & Dunevitz 1981, Anonymous 1999). At present, outside of Everglades National Park (ENP), there are 375 pine rockland fragments of approximately 1,780 ha remaining in Miami-Dade County (Anonymous 1995). Big Pine Key, part of the National Key Deer Refuge, retains the largest undisturbed tracts of pine rockland habitat in the lower Florida Keys totaling approximately 701 ha (Folk 1991, Hennessey & Habeck 1991, Salvato 1999). Although relict pine rocklands can still be found on several other islands within the refuge, only Big Pine maintains *C. linearis* (Salvato 1999). As a result, *S. a. bartrami* is present only on Big Pine within the Florida Keys. Here, populations of this subspecies range from locally common to prolific, limited by abundance of new host plant growth (Hennessey & Habeck 1991, Salvato 1999) and possibly the frequency of mosquito control pesticide applications to the pine rockland habitat (Hennessey et al. 1992, Salvato 1999, 2001). On the mainland, the butterfly maintains population levels that are sporadic and rarely encountered (Lenczewski 1980, Salvato 1999) in the Long Pine Key (LPK) portion of ENP, which contains the largest remaining coverage of pine rockland habitat (8,029 ha) on peninsular Florida (Anonymous 1999). Only a few of these fragments, ones that are adjacent to ENP, such as Navy Wells Pineland Preserve and Camp Owaissa Bauer Hammock, appear to maintain small, localized populations of *S. a. bartrami*.

FIG. 1. *Strymon acis bartrami* on Long Pine Key, Florida, November 22, 2003 (Photo Credit: H. L. Salvato).

Natural fires in the pine rocklands are a major force in regulating and maintaining the herbaceous layer of the pine rockland of which *C. linearis* is a part (Loope

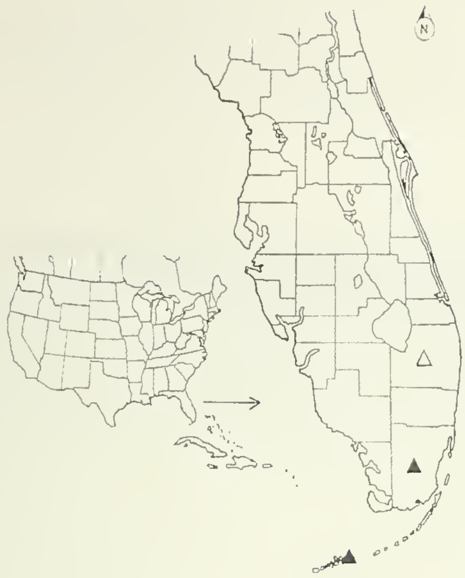

FIG. 2. Distribution of *S. a. bartrami* in Florida. Only Monroe and Miami-Dade Counties (black triangles) are confirmed as locations for the species. The occurrence of *S. a. bartrami* in Palm Beach County (open triangle) is unconfirmed. Adapted from Minno & Emmel (1995).

& Dunevitz 1981, Carlson et al. 1993, Olson & Platt 1995, Bergh & Wisby 1996, Platt et al. 2000). However, due to the proximity of remaining pine rockland habitat to urban areas in southern Florida and the keys much of these natural fires have been suppressed, often replaced by inconsistent regimes of managed or prescribed fires.

Prescribed fire has been consistently used for the past 50 years throughout the pine rocklands of LPK (Loope & Dunevitz 1981, Salvato 1999). From 1989 to date, LPK fire management has ignited prescribed fires every 2-3 years to mimic natural fire regimes historically instigated by lighting strikes (Robertson 1953, Slocum et al. 2003). Although this policy has resulted in restoration of species-rich herbaceous-dominated pine rocklands in many areas, including resurgence of *C. linearis*, the populations of this plant remain fragmented. Fragmentation may prevent *S. a. bartrami* from achieving the widespread distribution it maintains across the majority of Big Pine Key, where hostplants grow unrestricted in many areas (Lenczewski 1980, Hennessey & Habeck, 1991, Salvato 1999, Salvato in press).

During the few instances when the butterfly has been observed at LPK in recent decades (Hennessey & Habeck 1991, Emmel et al. 1996, Salvato 1999, Salvato in press), it has preceded new prescribed burns to the very areas where the localized populations of *S. a. bartrami* had been reported. MHS (unpublished) observed and monitored adult and larval *S. a. bartrami* activity in 2002-03 at gate 4 in LPK. The northern portion of gate 4 was burned on 10 May 2003. However, the majority of the southern portion was left unburned. Such burning of select portions of the pine rockland habitat has likely prevented extirpation of *S. a. bartrami* in LPK because partial and systematic prescribed burns may allow *S. a. bartrami* adults a corridor (refugium) for re-colonization. Numerous areas in LPK with smaller *C. linearis* densities have likely been lost to *S. a. bartrami* because these were entirely burned and lack adjacent host-bearing pine rockland refugia.

Another factor possibly complicating *S. a. bartrami* re-establishment between burn intervals is the length of time required for the host to regenerate sufficiently to be a suitable host. Lenczewski (1980), Hennessey & Habeck (1991) and Salvato (1999) have indicated that although *C. linearis* re-sprouts within one to three months after a fire, it appears in some areas inaccessible and in all instances undesirable to *S. a. bartrami* as a host source. We found that although *S. a. bartrami* is present in the pine rocklands following burns, they do not appear to oviposit on the new growth of *C. linearis*. A significant difference in the adult density of *S. a. bartrami* occurred in 1989 following a prescribed burn in October 1988 in Watson's Hammock on Big Pine Key, when compared to other study areas in Watson's Hammock and Big Pine Key that had not been burned at that time (Hennessey & Habeck 1991). MHS (unpublished) actively surveyed an 8 ha parcel of pine rockland on central Big Pine Key for *S. a. bartrami* prior to and following a prescribed burn administered in August 2001. MHS (unpublished) noted that, although ample amounts of host plant were available at about three months post-burn (during late November 2001) for oviposition, this new plant growth was not visited by *S. a. bartrami*. *S. a. bartrami* targets new growth for oviposition on otherwise established host plants (Hennessey & Habeck 1991, Salvato 1999). Prior to the August 2001 prescribed fire this survey location maintained an estimated *S. a. bartrami* population of 10 adults/ha (MHS unpublished). Following the August 2001 prescribed fire there were few observations of adult butterflies and no visible larval activity at the burned location until the following spring (late March 2002) when larvae were located on the resurgent host plants and adults were recorded at pre-burn abundance, a level they would retain until the next burn. MHS (unpublished) monitored a second prescribed burn at this same central Big Pine location that occurred in August 2003 and noted that, while still present at other survey locations, *S. a. bartrami* was absent at this burned site immediately following the fire. Lenczewski (1980) suggested that, although fairly common in nearby unburned locations, *S. a. bartrami* would not return to burned pine rocklands in Miami-Dade County for up to five months following a burn. From our observations of reduced adult and absent larval activity at burned locations (Hennessey & Habeck 1991, MHS 2001-03 unpublished), we suspect *S. a. bartrami* does not use *C. linearis* for oviposition for approximately eight months post-burn.

Watson's Hammock on northwestern Big Pine Key, where *S. a. bartrami* has historically been abundant, has experienced several decades of natural fire suppression combined with inadequate prescribed fire management. This has resulted in scattered populations of *C. linearis* and much lower densities of *S. a. bartrami*. Hennessey & Habeck (1991) recorded low densities of *S. a. bartrami* adults at Watson's Hammock as well as within LPK during their 1988-89 surveys. Although Salvato (1999, 2001) encountered large densities of *S. a. bartrami* adults at several areas of Big Pine Key during his 1997-98 surveys, a decline in numbers from previous studies was noted at Watson's Hammock and LPK. Continuing field surveys by MHS (unpublished) during 2002-03 have indicated that *S. a. bartrami* remains scarce within LPK (2 adults and a single 1st instar larva found over 30 sampling dates) and either extirpated or extremely localized throughout many areas in Watson's Hammock (12 adults found over 30 sampling dates).

The influence of burn intervals on threatened subspecies, such as *S. a. bartrami*, requires immediate investigation by researchers and land managers. More selective prescribed burns, coupled with augmentative adult *S. a. bartrami* releases could perhaps be used to increase population numbers in LPK and, if ultimately necessary, within Watson's Hammock.

Although restricted in the Everglades, chemical pesticide applications for mosquito control have been shown to play a significantly negative role in the natural history of butterflies in the Florida Keys (Emmel & Tucker 1991, Eliazar 1992, Hennessey et al. 1992), including those on Big Pine (Salvato 2001). The only pine rockland location on Big Pine where, historically, chemical pesticide treatments have been restricted is Watson's Hammock. Therefore any possible advantage the species might receive from the absence of chemical pesticides in Watson's Hammock is now difficult to ascertain due to a lack of consistent prescribed fire management needed to maintain adequate densities and distribution of hostplant.

**Natural history observations**. The natural history of *S. a. bartrami* was discussed initially by Comstock & Huntington (1943) and later by Opler & Krizek (1984). Smith et al. (1994) describe the taxonomy and ecology of various Antillean subspecies of *Strymon acis* Drury. Although briefly discussed by Chermock & Chermock (1947), it was Worth et al. (1996) who provided the most detailed natural history account to date of *S. a. bartrami* including a description of its early stages. Numerous notes were made on the natural history of this subspecies during field studies conducted by Hennessey & Habeck (1991) in 1988-89 and Salvato 1997-2003; some of these observations are reported in the remainder of this paper.

*S. a. bartrami* was observed on several occasions ovipositing on the terminals of *C. linearis*. Hennessey & Habeck (1991) observed a female oviposit three eggs over the course of five minutes. *C. linearis* is a dioecious plant. Most field observations of egg oviposition made by the authors Hennessey & Habeck (1991) (2 out of 2 in 1988-89) and MHS (unpublished) (39 out of 42 in 2002-03) were on male plants. Oviposition was observed only on flowering terminals. Beyond the first two instars, more mature larvae were located feeding throughout the host plant showing no apparent preference for plant gender. Hennessey & Habeck (1991) found six larvae (2 on female plants, 4 on male in 1988-89) and MHS (unpublished) has found larval stages (beyond the 2nd instar) feeding equally on both genders of host (25 female, 29 male during 1997-2003). We have recorded body lengths of 2, 4, 6 and 11mm for *S. a. bartrami* 2nd through 5th instar, respectively (based on 10 measurements of each instar in the field at Long Pine Key and Big Pine Key). Hennessey & Habeck (1991) estimated the duration time for developmental stages 4th instar through pupa to be 6, 7-9 and 13-14 days, respectively (however, this was based on only two field collected specimens from Big Pine Key). There have been no observed instances of obligatory relations of *S. a. bartrami* larvae and ants during this or other studies of the subspecies (Worth et al. 1996). Hennessey & Habeck (1991) collected a fifth-instar larva of *S. a. bartrami* on Big Pine from which a single braconid wasp was produced during pupation on 18 June 1989 . To our knowledge this is the only known record for a parasitoid from this subspecies. Due to the fact the subspecies pupates in the ground litter (Worth et al. 1996), tracking the fate of *S. a. bartrami* pupae is extremely difficult. Collection of other late instar *S. a. bartrami* larvae is needed to determine the influence of parasitism on its early stages.

We have recorded *S. a. bartrami* activity during every month on Big Pine Key; however the exact number of broods appears to be sporadic from year to year. Baggett (1982) indicated that *S. a. bartrami* seemed most abundant in October-December. Salvato (1999) recorded 92 adult *S. a. bartrami* from Big Pine Key during a one-week period in July 1997, suggesting the subspecies can occur prolifically. Adult *S. a. bartrami* were always found within the pine rockland habitat and in close proximity with their host (Schwartz 1987, Worth et al.1996, Salvato 1999). However, Minno & Emmel (1993) report a few records for *S. a. bartrami* from Key Largo, a location without historic records for the host plant. Although these individuals were likely strays from the mainland, the species is known to disperse when host plants are in flower. During the winter months on Mona Island (located between the Dominican Republic and Puerto Rico) large numbers of *Strymon acis mars* Fabricius have been recorded attracted to flowers of other plants when *Croton* flowers were scarce (Smith et al. 1994). *S. a. bartrami* was most often observed visiting flowers of the host during our studies in south Florida. Although it was observed visiting the flowers of several of the non-host species mentioned by other studies (Minno & Emmel 1993, Worth et al. 1996, Calhoun et al. 2000) for nectar, MHS (unpublished) frequently observed the butterfly visiting pine acacia, *Acacia pinetorum* (Small) Hermann (Fabaceae) on Big Pine Key.

The authors thank T. C. Emmel, D. H. Habeck, J. H Frank, D. M. Griffin III and J. C Daniels for advice and encouragement while conducting these studies. The authors thank J. Y Miller and L.D. Miller for access and examination of specimens at the Allyn Museum of Entomology (Sarasota, Florida) and J.B. Heppner for similar examination of specimens at the Florida State Collection of Arthropods (Gainesville, Florida), J. Bayless for consultations on the collections at ENP and J. Gilmore for field assistance, C. Campbell and A. Williams for plant identification. Salvato thanks H. L. Salvato for her extensive assistance during the 2002-03 field survey. Hennessey thanks R. M. Baranowski for providing laboratory facilities. The authors thank K. A. Schwarz and R. A. Worth for their encouragement, suggestions and insights on this research, and the natural history of these organisms. We thank C. M. Penz and two anonymous reviewers for comments that helped to improve the manuscript. The authors would also like to thank the staff of National Key Deer Wildlife Refuge, particularly B. Stieglitz, J. Watson, D. Holle, T. Wilmers, W. Miller, H. Cichon and R. Frakes, D. Gordon, C. Bergh, M. Folk and L. Flynn of The Nature Conservancy, and Everglades National Park, particularly S. Perry, for permitting and various technical support.

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*Received for publication 12 October 2003, revised and accepted 2 March 2004*

*Journal of the Lepidopterists' Society*
58(4), 2004, 227-229

# FEEDING ADULT BUTTERFLIES IN SMALL CAGES

**Additional Key Words**. butterfly feeder, lab-rearing, small cages

Most free-ranging butterflies feed frequently throughout their daily flight period and deteriorate if deprived of nutrients (Boggs 1997a, b, Boggs & Ross 1993). Although most caged Lepidoptera feed freely from open containers of sugar-water, they must be kept out of the solution or their wings stick together, stick to the cage, or stick to a cage mate. There is no way to clean the wings of soiled individuals and they deteriorate rapidly. Hand-held, pipette feeding is not a good long-term solution because it is time consuming and handling damages the wings, reduces longevity, and can alter behavioral and physiological phenomena being studied.

Most apparatus for feeding caged butterflies have large, exposed sticky surfaces, e.g., 1) saturated pads of polyurethane foam in 100cm petri dishes, 2) saturated cotton in 100ml beakers and 3) petri dishes of sugar water covered with bridal veil fabric (Hughes et al. 1993). Sticky surfaces are better tolerated in large cages, but cause big problems in small cages. Small cages keep the butterflies closer to the feeding station and their movements appear more erratic, less purposeful and result in frequent contact with objects in the cage. Unfortunately, large cages are not compatible with the parameters of some investigations, e.g., keeping experimental groups separated in temperature and light-control chambers, maintaining individual identification, and transporting alpine species to the lab in coolers.

Hughes et al. (1993) describe a feeder made from a conical centrifuge tube with a screw cap. The feeder I use (Fig. 1a) is similar, but is made from a syringe. Syringes are easier to fill, inexpensive, and available in more sizes. Also, the syringe barrel has flanges to hold

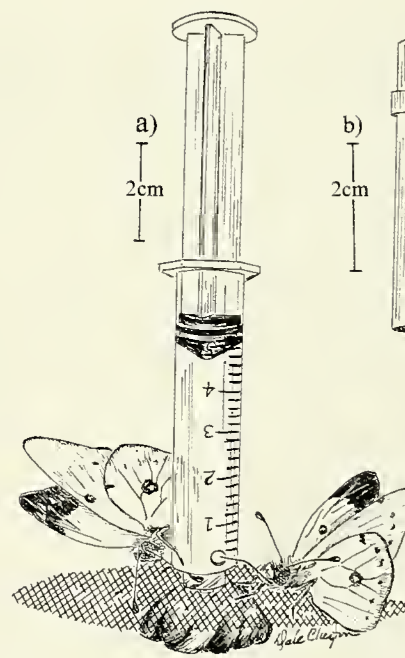


Fig. 1. a) *Colias eurytheme* at a 5 ml syringe feeder. A circle of fiberglass window screen between the syringe and modeling clay base keeps butterflies out of any sticky solution that might leak on to the cage bottom. b) A 6 X 50 mm disposable culture tube feeder with a ring cut from rubber or tygon tubing to keep it from slipping through a hole in top of the cage.

it in place when dropped through a hole in the top of a cage. The port designed to accept a needle is plugged by forcing a round wooden toothpick into the hole and breaking or cutting it off. A single feeding port is drilled in the side of syringe, at the needle end (see Fig. 1a). A hole should not be drilled through both sides of the syringe because if one hole is drilled